Running On Empty: Challenges In Bulk Fuel Support To The Marine Air Ground Task Force

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EXECUTIVE SUMMARY

Title: RUNNING ON EMPTY: Challenges in Bulk Fuel Support to the Marine Air Ground Task Force

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Thesis: Although the Marine Corps is developing operational concepts and technologies to improve its warfighting capability, it is neglecting the fuel support to sustain this improved capability.

Discussion:

The most challenging area of logistics, the provision of bulk fuel to the maneuvering force, is often neglected. Evolving requirements and the operational concept of *Operation Maneuver from the Sea* (OMFTS) are providing challenges in bulk fuel support to the Marine Air Ground Task Force. Current capabilities are designed to support traditional linear amphibious operations, are resource and time intensive, and require fixed, secured facilities ashore. The current systems and doctrine do not sufficiently meet the challenge of supplying fuel to high paced operations covering long distances, whether they be sustained operations ashore, operations other than war, or OMFTS.

The Marine Corps needs improvements in fuel distribution (both in ship-to-shore and inland distribution), and, most importantly, the reduction of fuel demand on the battlefield. Distribution can be improved through the development and procurement of an assault hose reel system, the development of integral fuel containers to the developing combat systems (MV-22 and AAAV), and the development of lighter weight fuel containers that can be transported on LCAC and tactical vehicles. Fuel reduction can be accomplished through improved tactical procedures and training, and through the development of more fuel efficient propulsion systems.

The Marine Corps Systems Command and several other agencies have been working these issues. However, there has been insufficient emphasis and resources applied to resolving this area of logistic support.

Conclusion: Procedures and systems need to be developed which provide the fast-paced, flexible support required by the Marine Corps of the future. The Marine Corps must place more emphasis and funding toward resolving this issue, in order to achieve a proper balance between combat power and the logistics required to sustain it.

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RUNNING ON EMPTY: Challenges in Bulk Fuel Support to the Marine Air Ground Task Force

INTRODUCTION

The most challenging area of logistics, the provision of bulk fuel to the maneuvering force, is one that is often neglected. The purpose of this paper is to describe the shortfalls in providing fuel support to highly mobile forces with immobile bulk fuel assets, to provide some direction in solving this problem, and to make military professionals more aware of the logistical implications of bulk fuel support. A key point is the requirement to provide responsive and flexible fuel support from a sea base, while also maintaining the ability to establish this support ashore. This latter case may be the likely course of action in operations other than war (OOTW) and during sustained operations ashore (SOA). The Marine Corps must identify how it plans to solve these issues, and where best to place limited funding in order to achieve a proper balance between combat power and the logistics required to sustain it.

Of significant note is the effort over the past four years to develop Marine Corps future capabilities through the operational concept of *Operational Maneuver From the Sea* (OMFTS) and its tactical counterpart, *Ship to Objective Maneuver* (STOM). These concepts call for the conduct of operations in the spirit of maneuver warfare. They describe highly mobile forces operating from a sea base, with reduced logistics buildup ashore. The current doctrine for logistic support requires a large logistical buildup ashore, as well as secured lines of communications to forward units. Accordingly, OMFTS and STOM are presenting challenges to the logistic community. Unfortunately, the Marine Corps is not placing the proper resources to produce the logistic capabilities to support these advanced concepts. All too often, the "high speed" combat systems receive priority, leaving the logistic capabilities wanting.

BACKGROUND

Karl von Clausewitz wrote that an army, and its commander, must be wary of exceeding its operational reach, thereby reaching the culminating point.[1] Going beyond this point risks failure and defeat. Logistics is one area in which a force can get overextended. Fuel support, or more accurately, the lack thereof, has had negative impacts on military operations since World War II.

During World War II and the Korean conflict, fuel was distributed in 5-gallon cans and 55-gallon drums. Distribution was very slow and resource intensive, requiring large numbers of trucks and personnel. In August of 1944, the "Red Ball Express" burned 350,000 gallons per day in their efforts to supply the equivalent amount of fuel to Patton's III Army as it advanced through France. Patton was eventually required to halt his offensive because his forces fell short of fuel. This delayed the defeat of German forces and the U.S. entry into Germany.

In the 1950s the Marine Corps developed a system "aimed at decreasing the dependency on drummed fuels in amphibious operations and expediting the supply of fuel to the beach."[2] Essentially, the Marine Corps moved from a packaged fuel supply concept to a bulk fuel concept. This system allowed for the movement of fuel ashore by flexible hoseline, and storage in large, collapsible tanks. This resulted in more timely support with fewer resources.[3] Distribution to the units was accomplished by either direct pumping from established fuel farms (dumps) or by tanker trucks delivering fuel forward.

CURRENT CAPABILITIES.

Essentially, the Marine Corps has been providing fuel support to the MAGTF in the same manner for the past four decades. The Marine Corps possesses a family of tactical fuel systems (TFS) designed to support the MAGTF, whether conducting amphibious operations, sustained operations ashore (SOA), or operations other than war (OOTW). For purposes of this examination, fuel capabilities are organized into three areas; storage, distribution, and demand. Storage includes those means by which fuel is contained and warhoused in preparation for distribution to using units. Distribution includes the means by which fuel is transported to storage sites and using units. Demand describes the consumption requirements of the force.

Currently, a Marine Expeditionary Force (MEF) possesses the assets to store eight million gallons of fuel in flexible, rubberized storage tanks. Each Force Service Support Group (FSSG) possesses eight amphibious assault fuel systems (AAFS), and each Marine Aircraft Wing (MAW) possesses 20 tactical airfield fuel dispensing systems (TAFDS).[4] Both these systems provide a large static storage capability, and a limited distribution capability. These systems consist of 20,000 gallon collapsible tanks, flexible hoseline, and portable pumps. Each AAFS stores 600,000 gallons, possesses 3.5 miles of hose, and constitutes the MEF's primary storage capability. Each TAFDS stores 120,000 gallons, and provides the fuel support to airfields or forward operating bases (FOBs). Each of these systems covers large areas of real estate and requires extensive manpower and equipment to establish and maintain. Additionally, each MAW possesses 18 helicopter expeditionary refueling systems (HERS). Each of these systems consists of (18) 500 gallon collapsible drums, portable pumps, and sufficient hose to refuel ground and air assets at forward arming and refueling points (FARPs).

Distribution covers two areas; the transportation of fuel from ship-to-shore, and the further distribution of fuel to elements ashore. For amphibious operations, doctrine calls for Navy ship-to-shore systems to transfer fuel ashore, employing the amphibious assault bulk fuel system (AABFS).[5] The AABFS provides a 10,000 foot buoyant fuel line from the supplying ship to the high water mark ashore where it interfaces with the AAFS system. The AABFS is employed to offload fuel from amphibious shipping and maritime prepositioning ships (MPS) in the initial phases of amphibious landings. Establishing the AABFS and the AAFS is not a speedy process. Doctrinally, it takes seven days to have a partial capability ashore, from which limited fueling can begin. However, it takes 14 to 15 days to have all AAFS systems ashore and operating at full capacity.[6]

Additional fuel support comes from follow-on tankers offloading via the offshore petroleum discharge system (OPDS). This can be installed up to 4 miles off-shore, and provides a significant replenishment rate. It consists of a single anchor leg mooring (SALM) with a surface buoy to allow the ship to moor. The flexible pipeline is laid along the sea bottom

to the shore. Like the AABFS, it interfaces with the AAFS at the high water mark. Installation requires underwater divers, amphibious construction battalion personnel and side-loading warping tugs.[7] Once the OPDS arrives in theater, it requires 2 days to install.[8]

A mixture of motor transport (surface) and aviation assets provide the capability to distribute fuel to MAGTF force inland. The vehicular assets are SIXCON modules and the M-970 refueler. The SIXCON system is made of containerized fuel and pump modules fit inside steel frames. The SIXCON fuel modules have a 900 gallon capacity. The pump module is designed to dispense fuel from several types of fuel tanks. Six of these SIXCON frames fit in the space of a 8'X8'X20' standard container, thus the name SIXCON. The SIXCON modules are transported either on LVSs (Logistics Vehicle, Support) or on 5-ton trucks. The M-970 refueler is a 5,000 gallon trailer pulled by a 900 series tractor. It is used for over-the-road transportation and aircraft refueling/defueling. Each MEF possesses 60 M-970s (20 in the FSSG and 40 in the Marine Aircraft Wing). Aviation assets include the helicopter expeditionary refueling system (HERS) and the tactical bulk fuel dispensing system in CH-53E heavy lift helicopter (TBFDS-CH-53E).[9] The TBFDS is internally loaded in the CH-53E and can be refilled through aerial refueling. It has a 2400 gallon capacity and is operated by the aircraft crew chief.

Until fuel farms are established ashore, the landing force relies on these surface and aviation distribution assets to transfer fuel directly from the ships. The vehicular assets move ashore on either LCACs (Landing Craft, Air Cushion) or LCUs (Landing Craft, Utility). Once the AAFS are established ashore, these same fuel distribution assets are used to move fuel to maneuvering forces inland.

As the landing force moves farther inland, it may require the movement of fuel farms forward, in order to reduce the distances traveled by the distribution assets. This is accomplished by "leapfrogging" AAFS systems forward and then either pumping fuel with the limited length of hose available, or by using vehicular assets to transport fuel to the next site. Again, this is a time and resource intensive endeavor.

The MEF also has a limited capability to distribute fuel using hoselines contained within

the AAFS system. Most commonly, however, these hoses are employed to provide direct flow between the AAFS and the TAFDS at an airfield or FOB.

Fuel demand is predicated on the size and type of force ashore, as well as the situation. The notional fuel requirement for a MEF, with a full Marine Aircraft Wing ashore, is approximately 1.2 million gallons per day.[10] Accordingly, a MEF can store six days of fuel in its organic assets. Smaller forces have smaller demand and require less fuel to be stored and distributed ashore.

The discussion above has described the resource and time intensive nature of present systems that provide fuel support to the MAGTF. The following discussion will describe the challenges to meeting fuel support to the MAGTF.

TODAY'S DEFICIENCIES AND TOMORROW'S CHALLENGES

Though the current fuel systems are designed to support a wide range of operations, there are challenges. Although these systems are more responsive than the "drum" system of WW II and Korea, they are hard pressed to support current maneuver capabilities, which require large quantities of fuel over great distances. The two most vexing problems of fuel support are the ship to shore movement and subsequent distribution of fuel to forces inland.

The elimination of LSTs (Landing Ship, Tank) from the naval inventory has greatly degraded the ability to support amphibious operations. With its reduced draft, bow thrusters, pumps, and causeways, this ship provided the ideal platform from which to emplace the Assault Amphibious Bulk Fuel System (AABFS). Because the AABFS only has a 10,000 foot reach, no other class of ship can get close enough to shore to install the system in most parts of the world. It will take some innovative ideas to provide this capability to transfer fuel ashore from the amphibious and maritime prepositioned force (MPF) ships.

Both the AABFS and the OPDS have limited reach from the shore. Accordingly, this type of support can only be accomplished in a benign or permissive environment, where the threat from modern anti-ship defenses is absent.

MAGTF fuel transportation assets are inadequate, in both quantity and capability. There

are insufficient M-970s, and even these lack an off-road capability, to support fast moving M1Al tanks, LAVs, amphibious assault vehicles (AAVs), and (in the future) AAAVs (advanced amphibious assault vehicles). Additionally, the SIXCON system has not lived up to expectations. Originally designed to fit six on an LVS, only three can be loaded because the high center of gravity with six modules causes the vehicle to be unsafe for off-road travel. This reduces the load from a programmed 4500 gallons to an actual load of 2700 gallons. During Desert Shield/Desert Storm, I MEF had to rely heavily on the substantial host nation support (HNS) that was available. Without this support, I MEF would have had difficulty providing the amounts of fuel required over the long distances involved. During Operation Restore Hope in Somalia, I MEF was operating in an undeveloped theater where HNS was not available. The MEF had to rely on its own assets to support itself as well as the joint and combined forces. This taxed the MEF resources to the utmost, even though daily consumption was only about 100,000 gallons per day.[11]

These motor transport deficiencies will be exacerbated if we plan to project power quickly and deeply inland. The MAGTF will reach its culminating point when motor transport assets can no longer turn around from the fuel source fast enough to support continued offensive operations. Unless additional assets are procured, or new capabilities developed, the landing force will be limited in the means to achieve its objectives.

Though the deficiencies discussed above describe problems with current capabilities, they will be even more crucial in higher tempo operations envisioned by OMFTS -- where highly mobile resupply capabilities must be the norm.

OMFTS meshes the tenets of maneuver and amphibious warfare and provides the vision for conducting amphibious operations in the future. *Ship to Objective Maneuver* (STOM) is the tactical concept for conducting the operations envisioned in OMFTS. These two concepts do not advocate conducting amphibious operations through the traditional objectives "aimed at the seizing of a beach"[12] by establishing the force beachhead, and then pushing inland. The goal of OMFTS and STOM is to move combat power (and logistics) ashore through the seamless

transition from maneuver at sea to maneuver ashore -- unlike the operational pause created when transitioning at the beach during traditional amphibious operations.

> Sustaining the landing force maneuver will be a critical challenge. Since the operational requirements of OMFTS and STOM are at odds with traditional methods of sustaining the landing force, the entire sustainment process will have to be examined.[13]

The current doctrine of establishing built up supply dumps is exactly what the OMFTS concept is trying to avoid. So, in addition to the difficulties involved in providing fuel support to contemporary operations, OMFTS requires even more mobile dispersed forces operating from a sea base. Current fuel capabilities do not meet this challenge.

These new concepts require logistic capabilities that are as mobile and responsive as the combat maneuver units they are identified to support. "Speed and mobility comparable to that of the assault forces are necessary to respond to the dynamic needs of OMFTS."[14] OMFTS requires "the CSS capability to provide completely sea based sustainment to rapidly maneuvering forces ashore for limited periods without secured overland routes."[15] STOM states that "C2, **logistics,** and fire support must remain organic to the maneuvering amphibious teams and/or remain sea based during the initial stages of the amphibious maneuver. The aim is to eliminate or reduce fixed and vulnerable activities and lines of communications ashore for as long as possible."[16]

In the future, the movement of fuel ashore will still require a mix of aviation and surface means. STOM envisions "LCACs and MV-22s providing the delivery mobility necessary to allow sea basing of much of our logistics effort. We can rapidly resupply maneuver forces directly from amphibious ships, significantly reducing floating dumps and freeing assets for other tasks."[17]

Significantly absent from STOM is a logistical role for the AAAV. The AAAV will improve MAGTF ship-to-objective maneuver from over the horizon (OTH). The AAAV will consume large amounts of fuel, particularly during the transit ashore. This vehicle greatly enhances the capability to project power directly from a sea base. However, if there are no

logistics systems in place to support it, it is useless. Additionally, providing fuel by air, as with the V-22 in the future, has its merits. However, using the V-22 by external sling loading either a 900 gallon SIXCON or two 500 gallon HERS pods significantly cuts this highly mobile asset's range to that of current rotary-wing aircraft; thereby negating its advertised advantages.

> The sea base envisioned by the OMFTS concept:
>
> is located within the battlespace that we intend to dominate, and it also serves as a beachhead, but afloat instead of ashore. From this floating beachhead, we can fully exploit maneuver warfare ashore by relying less on things that would tie us to static defensive positions --such as airfields, **fuel farms,** supply dumps, and a large command post. [emphasis added][18]

This concept supports rapidly maneuvering forces that are free from the hindrance of fixed faculties. However, in the mid term, concepts of CSS in support of OMFTS will require placing some CSS facilities ashore. Unfortunately, as previously described, our current capabilities rely on establishing these nodes ashore.

Paradoxically, there are additional challenges in many of the proposed solutions. There are a number of recent efforts being developed to answer the logistical portion of OMFTS and STOM.[19] Generally speaking, these all advocate the use of some sort of floating logistics platforms. These sea bases replace the traditional beach support area (BSA). The challenge, therefore, will be to move the supplies over the most demanding of environments, that of the sea. It is difficult enough to support the ground combat element (GCE) when the support has only to come from the beach. The extra demand of overcoming additional distances and movement over water multiplies this challenge. New ways must be found to move fuel from floating bases to rapidly maneuvering forces inland.

Planning solely to support over the horizon amphibious assaults envisioned in OMFTS may be to the detriment of other capabilities. When the MAGTF becomes involved in sustained operations ashore and certain OOTW operations, the likelihood is that the preponderance of the MEF will be ashore. Accordingly, bulk fuel demand will increase. The Marine Corps requires a flexible fuel system that supports the MAGTF across an entire spectrum of operations. As much as this paper has stressed the need for the assets to support OMFTS in the future, the Marine

Corps must possess a bulk liquid capability that is flexible, responsive and fast moving enough to support OMFTS, while also providing a robust capability to support sustained operations ashore and the logistically intensive OOTW operations such as disaster relief and humanitarian operations.

SOA and OOTW will most likely be conducted in a joint and/or combined environment. Accordingly, the Marine Corps must possess a flexible fuel system that can support high tempo operations over long distances from over the horizon and from a sea-base, and one that plugs into theater agencies during sustained operations ashore and other expeditionary operations. This is particularly necessary when the MAGTF is initially the supporting agency for other forces. This is more often than not the case, i.e., Operation Desert Shield/Desert Storm and Operation Restore Hope.

SUGGESTED SOLUTIONS.

> We are in a period of change in tactical concepts ... We can most certainly predict that ... petroleum handling equipment must be flexible, capable of quick response and rapid emplacement, and operable in varied terrain, all at the right time and the right place.[20] The operational concepts of warfare are in a process of change and will require much more flexible methods of fuel supply than in the past.[21]

Although this described the situation in the late 1950s, it is applicable to the current situation as the Marine Corps is currently at another such crossroads in fuel support. As during the last period of change, new ways must now be found to distribute fuel more efficiently, store it in more accessible locations, and reduce demand.

Solving fuel support to the MAGTF will require some innovative thinking, and the exploitation of advanced technologies. The Marine Corps Systems Command is working on several advanced concepts of technology that may help in this area. Presently, most initiatives are looking at improved ways to move the liquids to the supported units. This includes new lighter, more rugged containers. It also includes finding new "vehicles" on which to move these assets. Unfortunately, these systems are not mature. It will take some serious dedication of

resources within the Combat Development Process to get them there. This will require some to think outside the current paradigm.

However, the law of physics will only allow us to move only so much fuel, so far, so fast. Consequently, long term developmental efforts should concentrate on reducing fuel requirements on the battlefield.

Reducing the battlefield fuel requirement can be attacked in a number of ways. For starters, all future procurement programs must include the requirement for more fuel efficient engines. All Mission Need Statements and Operational Requirements Documents must include this initiative. The Marine Corps should also be addressing ways to move away from the reliance on fossil fuels. Alternate propulsion systems and energy sources should be aggressively pursued. This last idea is not as far-fetched as it might seem. There have been advances in hybrid engines and electric drives. The U.S. Army and the Marine Corps are conducting research and development into more efficient propulsion systems and tactical and electric vehicle technology (TEVT).[22] The demonstration of an electric drive in an LVTP-7A1 (amphibious assault vehicle) has been successfully accomplished while maintaining full operational capabilities.[23] This program links the diesel engine with a high performance alternator providing electric power to the drive. This has resulted in great fuel savings, as the engine must only drive the alternator. Other agencies are also exploring alternate propulsion technologies.[24]

Additionally, we must find ways to reduce consumption of fuel through conservation on the part of the operator. Through doctrinal, and training and educational changes, we need to strive for procedures that use less fuel, and train operators to shut down fuel-burning assets whenever possible. The draft of *A Concept for Precision Logistics* [25] has offered such an idea. "Precision Logistics equates to more than the activities associated with the logistics tail. It involves supply discipline at the small unit level, routine maintenance, flexibility of supply and maintenance systems to change to the tactical situation."[26] In other words, the warfighters must learn to conserve as much fuel as possible. Some initiatives have been pursued, i.e., the new auxiliary power unit (APU) on the M1Al. This small generator saves fuel by providing an

alternate power supply when the main turbine is not required. An idling turbine engine burns nearly as much fuel in a stationary position as while maneuvering on the battlefield.

By decreasing fuel requirements, we reduce storage and distribution requirements. However, this does not necessarily reduce the distribution challenges. As discussed earlier, the challenge in distribution is that environment from the ship to the shore. Accordingly, the Marine Corps must also strive to improve distribution capabilities.

Increasing fuel distribution can occur a number of ways. The fastest way to move fuel is still by pipeline. This is the preferred method by industry and by all military services. The Marine Corps should procure a flexible pipeline system that increases the distribution rate inland, and that can be installed rapidly. Following this philosophy, the Engineer Program Manager at Marine Corps Systems Command has developed an assault hose reel system (HRS) to push fuel quickly inland. As envisioned by the procurement plan, this system will provide the MEF with 40 miles of hoseline that can be emplaced at 5 miles per hour. This will provide for significant time and manpower savings in delivering fuel to those forces maneuvering inland.[27] Having this asset will preclude waiting for the establishment of AAFS before pushing fuel inland. It will also provide the capacity to tie into theater assets in SOA and OOTW, thereby reducing the reliance on motor transport to support the operational level fuel support. This will free the motor transport assets to support the tactical maneuver elements. Though we are striving for highly mobile CSS in OMFTS, we will still require the ability to move large quantities of fuel in SOA and certain OOTW scenarios.

An added benefit of increased distribution capabilities is a reduction in the amount of storage required ashore. However, we need to pursue storage capabilities that are lighter and less resource intensive to install and remove for those instances when their use is required.

Another alternative to improving the distribution capability is to explore new packaging systems. Marine Corps Systems Command, in conjunction with the Naval Engineering Facilities Service Center (NEFSC), is exploring innovative packaging systems, as part of the Advanced Expeditionary Combat Service Support program. They are addressing new technologies and

materials in fuel distribution in their Expeditionary Bulk Liquids Technology (EBLT).[28] This program hopes to

> ...identify and develop technologies that can reduce demand on shore and/or increase CSS system capability by: increasing material transport capability, reducing tare weight, transferring maximum service support capability from shore to sea-base, and improving ship-to-shore transfer efficiency.[29]

One other measure is to place fuel systems on LCACs to refuel combat vehicles ashore. I MEF has experimented with this. They placed a 20,000 gallon tank on an LCAC, filled it with 13,000 gallons, and were successful in transferring this resource ashore. Additionally, the Coastal Systems Station, Panama City, Florida is developing an LCAC that is configured to provide forward arming and refueling point (FARP) support, the Mobile Forward Arming and Refueling Point (MFARP). Unfortunately, a drawback when using LCACs is that they are taken away from moving additional combat power (tanks, LAVs, artillery) ashore.

If the Marine Corps is serious about getting away from secured lines of communications and fixed sites ashore, it must provide organic logistic capabilities to the maneuver systems being developed. Acquisition strategies must provide the maneuver units the capability to take their fuel support with them. The Marine Corps should be developing and procuring systems similar to the TBFDS-CH-53E for the AAAV and the MV-22. This will provide for that balance between combat power and sustainment described earlier. Special Operations Command has developed an integral fuel system for their version of the MV-22. It has a 1600 gallon capacity and is similar in design to the TBFDS-CH-53E.[30] Additionally, procurement managers should be identifying auxiliary fuel storage capabilities for current combat systems, making them more autonomous and thus requiring refueling support on a less frequent basis.

In order to improve the transportation of fuel ashore, the Navy/Marine Corps team needs to replace the off-shore capability previously provided by the LST class of ship. We must be able to establish fuel lines ashore during those operations that require large quantities of fuel, such as certain OOTW operations and during subsequent operations ashore.

There are no requirements documents for new programs, or even for the procurement of

additional systems (other than the HRS).[31] The one system that has been developed has yet to make the budgetary cut of the Program Objective Memorandum (POM). The HRS was included on the Marine Corps Programmed Objective Memorandum (POM) for FY96. However, it fell below the funding line. In the current FY98 POM, the hose reel is listed as the 133rd priority by MCCDC, out of a list of 193 items.[32] This indicates the lack of importance placed on fuel support by the Marine Corps planners and programmers. It is for this reason that many are concerned that there is a imbalance between the combat capabilities being sought for the Marine Corps of the future, and the logistic capabilities to support them.

CONCLUSION

This paper has discussed the requirements for fuel support to the landing force, both today and into the future. Many of the challenges and deficiencies have been identified through advanced concept development, several Mission Area Analyses studies, lessons learned reports, and through a myriad other studies. Unfortunately, there have been few gains to improve this area of logistic support.

To provide the best fuel support to the MAGTF, the Marine Corps must strike a balance between the maneuver capability desired to implement OMFTS and the logistics capability to support it. The concern is that we will have a modern power projection capability hampered by a 1950s/1960s technology, if we do not begin seriously applying resources toward the problem of supplying this ambitious maneuver warfare plan. Bulk fuel support is a vital part of CSS, especially for maneuvering forces. Improving current capabilities will take us just so far. This will require some hard choices by the senior Marine Corps leadership. This includes shifting emphasis that the current C4I and combat systems presently receive, to a balanced approach that best provides a well rounded, flexible combat capability. If we are not careful, the operational success envisioned by OMFTS will be defeated by the inability to support it logistically. The logistics concepts and initiatives are lagging behind the operational ones. We must find a way to integrate sustainment with maneuver and the other functions in the battlespace.

ENDNOTES

[1]Carl von Clausewitz, *On War* (Princeton: Princeton Press, 1976), Book Seven, Chapter 22.

[2]Horace H. Figuers, Col, USMC, *Research and Development in Military Petroleum Packaging and Transmission in Temporary Systems*, Individual Thesis, Industrial College of the Armed Forces, 30 April 1959, 21.

[3]The initial tanks held 5,000 gallon tanks. Over the years they have been replaced with 20,000 gallon bladders. The Marine Corps is currently investigating the use of 50,000 gallon tanks to replace the 20,000 bladders.

[4]This information applies to I MEF and II MEF. III MEF has a smaller systems mix due to the downsizing that occurred in that command.

[5]Marine Corps Warfare Publication (MCWP) 4-18, *Bulk Liquids Operations (Coordinating Draft)* (Washington, DC: Headquarters, United States Marine Corps, February 1995), 1-4.

[6]CWO5 David Willoughby, Executive Officer, Marine Corps Detachment, Ft. Lee, VA, interview by author, 19 December 1995.

[7]MCWP 4-18, 2-5.

[8]Willoughby.

[9]Marine Corps Systems Command, "Tactical Bulk Fuel Delivery System, CH-53E (TBFDS, CH-53E)," Fact Sheet, Program Manager, Engineering Systems, undated.

[10]MCWP 4-18, 4-5.

[11]Marine Corps Combat Development Command, "Operation Restore Hope Collection and Lessons Learned Project Report," Quantico, VA, 27 April 1993.

[12]Fleet Marine Force Reference Publication (FMFRP) 14-24 (Coordinating Draft), *Ship to Objective Maneuver* (Quantico, VA: Marine Corps Combat Development Command, 14 February 1995), 5.

[13]FMFRP 14-24, 20.

[14]Fleet Marine Force Reference Publication (FMFRP) 14-21 (Coordinating Draft), *Operational Maneuver From the Sea* (Quantico, VA: Marine Corps Combat Development Command, 31 March 1995), 17.

[15]FMFRP 14-21, 21.

[16]FMFRP 14-24, 9.

[17]FMFRP 14-24, 12.

[18]Cdr Terry Pierce, USN, "Operational Maneuver from the Sea," *Proceedings* (August 1994), 31.

[19]Several agencies and study groups have begun to address the supply of bulk liquids as part of overall logistic concepts in support of OMFTS. A joint endeavor by Deputy Chief of Staff, Installations and Logistics, HQMC and CG, MCCDC have produced a draft of *A Concept for Precision Logistics.* In November 1995, MCCDC and I&L were instructed to place this concept on hold while they developed the concept *of Maritime Prepositioning Force 2010.* Additionally, the Naval Facilities Engineering Service Center contracted a study titled *Marine Corps Logistics "2010."*

[20]Figuers, 41.

[21]Figuers, 50.

[22]United States Marine Corps, *Marine Expeditionary Development Program Fiscal Year 1996 Technology Program Plan* (Quantico, VA: Marine Corps Combat Development Command and Marine Corps Systems Command, September 1995), 141.

[23]Marine Corps Systems Command, *Marine Corps Advanced Technology Demonstration/Advanced Development Master Plan,* (Quantico, VA: Amphibious Warfare Technology Directorate, 1 May 1994), 1-11.

[24]For additional information, refer to Hewish, Mark. "Fuel Cells Come of Age." *International Defense Review,* no. 9 (1995): 78, and Hare, Ron, and Alan Loss, "Electric Drives for Modern Combat Vehicles," *International Defense Review,* no. 3 (1990): 307-310.

[25]United States Marine Corps, *A Concept for Precision Logistics: A Marine Corps Logistics Concept for the 21st Century (Draft),* Marine Corps Combat Development Command and Deputy Chief of Staff, Installations and Logistics, Headquarters, United States Marine Corps, August 1995.

[26]United States Marine Corps, *A Concept for Precision Logistics.*

[27]According to United States Marine Corps, "Hose Reel System: IDS #26-28" Brief from PM Engineer, Marine Corps Systems Command, 26 January 1996, if this system is not funded, the Marine Corps will possess no capability to rapidly/effectively support widely dispersed airfields and ground refueling points; inability to provide fuel "farther, forward, faster" to rapidly moving lead elements will effect MAGTF's capability to sustain operational tempo.

[28]United States Marine Corps, *Marine Expeditionary Development Program Fiscal Year 1996 Technology Program Plan*, 251.

[29]Ibid, 267.

[30]Discussion with Major Keith Sweaney, former V-22 project officer, HMX-1, of 15 February 1996.

[31]Based on interviews with Major Martin Wasielewski, USMC, Engineer Requirements Officer, Marine Corps Combat Development Command of 15 January 1996, and Major Thomas Connors, USMIC, Motor Transport Requirements Officer, Marine Corps Combat Development Command of 11 February 1996.

[32]Commanding General, Marine Corps Combat Development Command. Memorandum for Distribution 3900 C 39. Subject: "MAGTF Prioritized List of Requirements (PLR) and POM 98 Acquisition Initiatives List." 19 December 1995.

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